

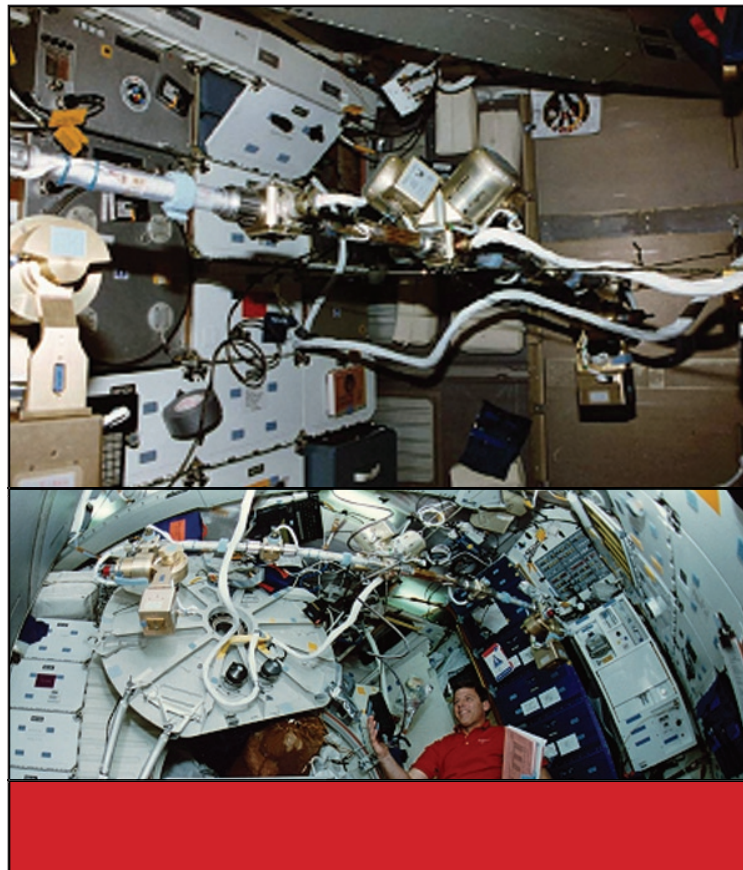


Air Force Research Laboratory|AFRL

Science and Technology for Tomorrow's Air and Space Force

Success Story

MIDDECK ACTIVE CONTROL EXPERIMENT REFLIGHT PROGRAM



Middeck Active Control Experiment (MACE II) Reflight program research demonstrated and validated adaptive structural control in space. This research will allow future spacecraft designers to develop lighter, more flexible spacecraft structures while meeting ever-increasing performance requirements. Adaptive structural control can autonomously create its own control algorithms and greatly decreases modeling and control system development costs. In addition, the adaptive controls approach greatly decreases assembly, integration, and test costs.



Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

The National Aeronautics and Space Administration (NASA) selected MACE II as the first active science experiment aboard the International Space Station (ISS). MACE II returned to Earth after nearly a year of successful operations on-orbit. The Space Vehicles Directorate-led science teams demonstrated and validated autonomous, adaptive structural control algorithms to control flexible structures without the need of extensive modeling and testing prior to use.

These algorithms have the capability to characterize the system dynamics using solely the on-board sensors and actuators and then autonomously create effective structural control systems to minimize pointing errors in the presence of on-board disturbances. In addition, these adaptive control algorithms demonstrated recovery from “failed” actuators.

As an experiment, Astronaut Susan Helms (Colonel, US Air Force) caused the actuators to fail by zeroing out their response. The adaptive controllers sensed this failure and reconfigured the control system to maintain performance. Colonel Helms performed over 100 protocols, or experiments, for MACE II during her stay on ISS.

Background

The directorate wishes to acknowledge the outstanding efforts of the Department of Defense (DoD) Space Test Program (STP) managed by Space and Missile Systems Center. STP provides space flight for qualified DoD-sponsored experiments at no charge to the experimenter via the DoD Space Experiments Review Board.

The directorate leveraged existing flight hardware developed by the NASA Langley Research Center and the Massachusetts Institute of Technology (MIT), together with a Small Business Innovation Research Phase II contract, a Cooperative Research and Development Agreement, and two educational Partnership Agreements, to create the MACE II program.

The MACE II program had two separate science teams developing structural control algorithms to demonstrate vibration suppression and precision pointing of flexible structures. The directorate-led science team includes Planning Systems (Melbourne, Florida), Payload Systems (Cambridge, Massachusetts), the University of Michigan, Virginia Tech, and Sheet Dynamics, Ltd. (Cincinnati, Ohio). The MIT-led team includes MIT, Mide Technology (Cambridge, Massachusetts), Lockheed Martin, and NASA Langley Research Center.

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (02-VS-06)

Space Vehicles
Emerging Technologies